Available online at www.sciencedirect.com

ScienceDirect

Procedia CIRP 17 (2014) 356 – 361

www.elsevier.com/locate/procedia

Variety Management in Manufacturing. Proceedings of the 47th CIRP Conference on Manufacturing Systems

Involvement of Procurement in the Product Creation Process: A Systematization Scheme of Measures

Florian G. H. Behncke[a]*, Jonas Eichinger[a], Udo Lindemann[a]

[a] *Institute of Product Devalopment, Technische Universität München, Boltzmannstrasse 15, 85748 Garching, Germany*

* Corresponding author. Tel.: +49-89-289-15138; fax: +49-89-289-15144. *E-mail address:* behncke@pe.mw.tum.de

Abstract

Manufacturing firms transferred a significant share of their value creation in terms of the development and manufacturing to suppliers, while concentrating on their core competences. The subsequent integration of suppliers challenges the procurement department as connector between internal organizational customers and external suppliers in the supply chain network. Over the last decades, industry and academia provided numerous measures that address specific situations in this involvement process. However, there is a lack in literature on their systematization. This paper aspires a systematization scheme of measures for involving procurement in product creation processes describing the measures against a set of classifying criteria.

Selection and peer-review under responsibility of the International Scientific Committee of "The 47th CIRP Conference on Manufacturing Systems" in the person of the Conference Chair Professor Hoda ElMaraghy"

Keywords: Procurement, Product Creation Process, Measures, Systematization Scheme;

1. Motivation for the involvement

Manufacturing firms face emerging global markets in the midst of the transformation from a sellers' to a buyers' market [1]. To prevail in this fierce competition manufacturing firms rethought their concept of cooperation and concentrated on their core competences [2]. This cultivation and exploitation of core competences lead to a transfer of their value creation in terms of developing and manufacturing to their suppliers that are arranged in a supply chain network (SCN) [3]. The subsequent integration of suppliers in product creation processes (PCP) challenges especially the procurement as connector between internal organizational customers and external suppliers in the SCNs [4]. At the same time the number of variants and the complexity of products as well as its creation process increases [5]. Over the last decades, industry and academia provided numerous measures for an early involvement of procurement and suppliers in PCPs. These measures address certain situations occurring in this involvement process like standardization and bundling of procurement requirements in order to cope with the increased complexity of the product and its SCN [6, 7]. Due to the nature of situations these measures are diverse. This requires a systematic overview of measures in order to provide a decision support for manufacturing firms. However, literature is not delivering a corresponding systematization of measures. As a result, the primary objective of this paper is to provide a systematization scheme of measures for the involvement of procurement in PCP. This paper describes the concept of the PCP (1.1) and the fundamentals of procurement and the corresponding procurement process (1.2) as basis for the systematization scheme of measures (3.3).

1.1. Product Creation Process (PCP)

The PCP is essential for involving procurement through certain measures [8]. Thereby, this process refers to all workflows of a manufacturing firm from the idea for a new

Selection and peer-review under responsibility of the International Scientific Committee of "The 47th CIRP Conference on Manufacturing Systems" in the person of the Conference Chair Professor Hoda ElMaraghy"

doi:10.1016/j.procir.2014.01.078

product to its serial production. The impetus for the launch of a PCP can be of various origins. On the one hand the impetus can be formed by the need of the market (market pull), on the other hand the PCP can also be initiated by a progress in technology (technology push) [9]. Different approaches for a phase model of the PCP is provided by literature [8, 10]. The description of a phase model is necessary for an explicit assignment of measures to the PCP. This assignment allows a first systematization of measures.

This paper uses a six-step phase model for the PCP. The starting point of any PCP is the project order by the manufacturing firm's management, which is formulated on the basis of long-term firm strategies and product strategies [11]. Based on the project order the idea phase is following the generation, collection and evaluation of ideas (PCP-1). The next step (PCP-2) is formed by the definition of the product. This covers the first definition of requirements for the product as objective of the development [11]. The essential target of the subsequent concept development phase (PCP-3) is the development of the product architecture as description of the product from the perspective of its functions and components [12]. The product architecture is the basis for the creation of modules [12]. For the manufacturer of a product, the definition of its product architecture and its constituents at the level of concrete dimensions represent a necessary condition. This concretization takes place in the context of the phase of product development (PCP-4) [11]. At the same time the production process has to be developed in this step [9]. The start-up phase (PCP-5) with the preparation of production and finally the serial production (PCP-6) complete the PCP [8].

1.2. Procurement and the Procurement Process (PP)

The objective of the paper at hand is to involve the supply function of a firm in the PCP at an early stage by developing a systematization scheme for measures. Since such measures are of a strategic nature, the concept of purchasing with its often operative and dispositive character is not supporting the objective of this paper. The procurement concept shows some similarities to the purchasing, but emphasized the security of supply. This depends on internal aspects as well as on the situation in the procurement market such as the economic situation or the capacity of suppliers. Procurement has a deeper responsibility. The creation of a value-added relationship with suppliers in the procurement market and the early recognition of market developments to exploit technical potential for success are major objects of consideration, justifying an involvement of procurement in the development activities [13].

Literature provides various established models to describe the procurement process (PP) [14]. Most of them are formed by three phases and put their focus on the perceptive of operational activities like negotiations and settlement [15]. Others focus on the perspective of long-term tasks of the procurement as well as on the order processing aspect of the PP [16]. However, none of the mentioned phase models is able to capture the early involvement of procurement aspired in this paper. Since measures that describe such an early involvement, are more of a strategic nature, the description of an operational PP cannot be used as a basis for the systematization of these non-operative and dispositive measures. In the existing phase models for the strategic PP one or more phases are missing in terms of an early involvement of procurement in product development. A vital example is featuring the role of procurement as a coordinator between the in-house development and the development of cooperating suppliers. For this reason the following six-step phase model for the PP is introduced [8, 17].

The first phase (PP-1) covers procurement activities that affect the generation, collection and evaluation of ideas for a project or a product. This includes the procurement market research to monitoring current technological developments and competitive products. It also includes activities such as the selection and coordination of suppliers involved in the generation of ideas or a subsequent definition of requirements. The second phase (PP-2) focuses on influencing the development of a new product and controlling through specifications. This includes inquiry of using alternative materials or parts such as standardized or repeat parts for the bundling of requirements as well giving suggestions in terms of availability, quality, cost and delivery times of certain components that need to be purchased [17]. The third phase (PP-3) involves a make-or-buy analysis. Accordingly, it is essential to select suitable suppliers or rather plan and initiate the development of a new supplier if required [8]. In the fourth phase (PP-4), procurement deals with the embodiment of the sourcing strategy developed in the previous phase. Thus, it can either be the development of a suitable development cooperation depth as well as the development of an organizational structure of a supplier relationship. As a result, procurement at this stage occurs as a coordinator between the in-house and the supplier's development. The fifth phase (PP-5) describes the activities of the classic procurement. It is primarily concerned with the supply of less complex parts, whereat the price is the center of attention. Likewise, the order management (e.g. invoice processing, logistics planning …) is implemented. The sixth phase (PP-6) – referred to as controlling – can be understood as a cross-cutting issue throughout the entire PP. It refers to the continuous monitoring of the performance of suppliers as well as the checking of invoices. This is only possible after an agreement with a supplier and an operating SCN, so that it represents separate phase at the end of the PP.

2. Research methodology

The involvement of procurement in the PCP has two major perspectives (product development and procurement) as it intends an involvement of procurement activities in product development. Thereby, the PCP (1.1) sets the impulse of manufacturing firms as core business process. Therefore, a comprehensive understanding of this process and its major activities is essential for the incorporation of other activities like those from procurement. The PCP is derived from literature in the field of product development and focuses on contributions that show a distinct support of activities from other disciplines especially like procurement. The PCP

provides a backbone in the field of product development for the aspired systematization of measures.

The other perspective requires an overview of activities in procurement. Those activities are derived from international journals that are related to procurement, purchasing, supply chain management and other related fields. These activities are gathered and summarized in the PP presented in section 1.2. Thereby, the inclusion of activities in the PP depends on the presence of an implication on the PCP. A vital example for such implications is premises in procurement on sourcing strategies. For instance modular souring strategy somehow implies modular product architecture, which is determined in the conceptual design of the PCP.

Based on these process related perspectives on involving procurement in the PCP, measures and further distinctive characteristics of them are conducted in a literature review deploying commonly used scholar databases and book publications on procurement, purchasing and supply chain management. Thereby, measures are included in the literature review as long as they either affect the PCP through certain implications or require a consideration within a distinct phase of the PCP. As the conducted measures vary in terms of the scope of the involvement of procurement in the PCP the performed literature review was expanded. Therefore, the review features a summary of criteria to describe certain characteristics of the measures. These criteria are the basis for the systematization of measures. The resulting systematization scheme features a description of measures from the literature review using the criteria that define distinctive characteristics of the measures. The scheme is evaluated by an expert focus group from the field of product development as well as procurement. Along with the introduction of a supplier nomination process at a manufacturing firm the different measures listed in the scheme are discussed according to their characteristics within three using semi-structured workshops. Due to the nondisclosure-agreement with the manufacturing firm no further details on the workshops and the supplier nomination process are available for publication purposes.

3. Systematization scheme of measures

This section provides an overview of other criteria (3.1) for the description of distinctive characteristics of the conducted measures (3.2). Section 3.3 summarizes the measures and criteria in a systematization scheme (3.3), which is the object of discussion followed in section 3.4.

3.1. Criteria for the systematization

This paper provides seven different criteria to describe the characteristics of measures to involve procurement in the PCP. As a result, the first criterion is the assignment of measures to a corresponding phase in the PCP (1.1). Another criterion is the phase within the PP (1.2), which is conducted from literature in order to provide activities that might be involved in the PCP. Analogous to the PCP systematization is achieved through the assignment of the measures to corresponding phases of the PP. According to literature, there are five different levels of responsibility for the involvement of procurement in PCPs. Those responsibilities describe whether the involvement is related to specification, operation, preparation, politics or structure. At the first level of responsibility the procurement has a design or specification responsibility. This means the influence of procurement on the current development of the product in terms of components, modules or systems of suppliers or by focusing on important aspects from the procurement's perspective. This includes the checking of the availability of a required technology, the demonstration of technological developments in the supply market and the consideration of capacity constraints of certain suppliers. The operation responsibility is the second level of responsibility. Tasks such as project-related planning and coordination of development activities of the cooperation partners are the main issues of this level. The preparation and impetus of a development project takes place on the level of the preparation responsibility. Unlike the previous levels, activities of the fourth level (structure responsibility) are not only based on a particular development project, but refer to the structure of the supplier base of a firm. The policy responsibility ultimately relates to the formulation and communication of policies and strategies for the involvement of procurement in the PCP [18]. As any measure pursues a specific objective, another criterion captures their influence on the four major performance indicators relating either on the firm's performance or on the product that is developed. Those indicators are defined as reduce costs, increase performance, mitigate risk and increase flexibility [19]. Furthermore, it is important to distinguish that reduced costs and increased performance are related to the product, whereas mitigated risk and increased flexibility are related to the firm. Different situations in supply markets, expressed by the demand power of the manufacturing firm and the supply power of the supplier are included in the systematization scheme. Demand and supply power are influenced by diverse factors of the market, the manufacturing firm and suppliers. Examples for factors that influence the supply power are: structure of supply, economic situation, the exclusiveness of the supplier's products, and barriers to entry for new rivals. Flexibility of a firm relating to make-or-buy, the possibility of developing suppliers as well as switching costs are examples for factors influencing the demand power of a firm [20]. Different measures are executed reasonably dependent on different market powers of the two protagonists; the manufacturing firm and its supplier. Within the early involvement in the PCP, procurement plays different roles acting as a driver, an influencer or a participant when performing certain measures [8]. This criterion is used to identify a person or a division of a firm that is responsible for initiating, executing and controlling certain measures.

3.2. Measures for the involvement of procurement

This paper conducts 38 measures for the involvement of procurement in PCPs. The measures are ordered in seven categories according to their distinctive characteristics (3.1).

The first category is formed by measures that describe an incentive system (A). One way to move suppliers to cooperate within the PCP, is the initiation of an innovation prize (1),

whereat the most innovative and efficient supplier of a firm is awarded. The created competition among suppliers is intended to motivate them to contribute their innovation knowledge to the firm and to improve their own performance [9]. With the implementation of a supplier day (2) suppliers can be motivated to cooperate with the firm. Suppliers' days are events where issues of cooperation between customers and suppliers are treated in lectures and group work [21]. Another incentive for a supplier to cooperate with its customers is its participation in the earnings of the customer. It is possible to share the revenues (3) or benefits (4) of the firm with suppliers and thus let them participate in the risks and chances [20]. Supplier workshops (5) are used to foster the collaboration with suppliers. Innovation workshops in which suppliers and customers work together on new ideas and place principles for future cooperation [9]. Regular supplier visits and discussions (6) foster the emergence of cooperation.

The second category summarizes measures, which relate to the firm's sourcing (B) [19]. Single Sourcing (7) means the intended procurement of an object from one supplier. Dual Sourcing (8) implies the procurement of an object from two different suppliers for the purposes of taking advantage of their competition, whereat Multiple Sourcing (9) describes the sourcing from many different suppliers. Those measures therefore differ in the number of suppliers. Another distinction is the geographical dimension of the procurement. Local Sourcing (10) refers to the terrain in the vicinity, whereas Global Sourcing (11) implies purchasing from all over the world. Taking into account the complexity of the procurement object, four different measures can be deduced. Parts Sourcing (12) means the procurement of parts where no installation has taken place, further disassembly is therefore not possible. Component Sourcing (13) refers to the procurement of objects that are composed of different items; however, compared to modules and systems, they have a lower degree of aggregation. The options Modular (14) and System (15) Sourcing describe a bundling of needed services to complete, in parts pre-assembled functional units. With modules design and development performance is largely provided by the buyer, while the supplier will be responsible for the production. In contrast, systems suppliers are responsible for most of the development work as well as for the majority of the of the production and logistics issues.

The degree of integration of the customer and the degree of autonomy of the supplier is used for system suppliers to distinguish different depths of the development (C). For in-house development (16) the customer provides the overall development performance itself, thus the influence of the supplier is limited to production-related matters [8]. In the interface model (17) the customer is responsible for defining the overall concept, the benefits and the philosophy of the new system. Requirements for a technical implementation are derived from this by the manufacturing firm, which then build the interfaces between the customer and supplier. While the development of solutions is made by the supplier, the system leadership remains with the customer [8, 9]. A team model (18) describes the cooperation of suppliers and customers for the entire period of development as equal partners. In these teams, which consist of both employees of the supplier as well as from the customer, the design of the system is developed together [9]. In the black box development (19) the system is exactly specified by the customer. The development of the technical implementation of these requirements is, however, only executed by the supplier, so that the outcome of the development depends solely on its development skills. Finally, the external development (20) implies the development of a system solely by the supplier. This system may then be used with slight modifications by several customers [9].

The next category is given by the supplier selection (D). The classic bid invitation (21) is used to get offers from suppliers for a mostly specified procurement object. Online auction (22) refers to the creation of virtual marketplaces where simultaneously and transparently all their suppliers make offers for a certain need of the manufacturing firm [9]. Concept competition implies the selection of a suppliers based on its performance in a competition in which different suppliers develop a concept for a problem formulated by the firm [21]. The so called RFI/RFP process consists of two consecutive sub-processes. First, a small number of key information is requested from a very large number of suppliers by a Request for Information (RFI) (24). In the next step very accurate information is demanded from a smaller number of suppliers by a Request for Proposal (RFP) (25) [20]. Direct award (26) is the selection of a supplier without making a thorough search and evaluation of available suppliers. The aim is to minimize time and financial expenses of the supplier selection [9].

Standardization and bundling are forming the next category (E). The purpose of standardization (27) is the use of standard parts in products to achieve a reduction of complexity and costs [22]. There are approaches to bundling of requirements. The first approach bundles requirements across product lines (28), describing the idea of using the same components for different product lines. The second approach bundles across product generations (29) following the idea to contract a supplier with for parts of several product generations or projects [20].

The following three measures cannot be assigned to a certain category (F). The objective of product benchmarking (30) is to obtain information on their specifications and their production by comparing alternative products on the market and thereby achieve lower costs for their own products. The purchase of a supplier (31) is defined as the buy of a supplier by a customer. The purpose of this acquisition is counteracting a shortage of capacity or resources. Supplier development (32) is meant to enhance the performance of existing or new suppliers [20].

The last category summarizes measures describing the cooperation within the PCP (G), whereas each phase represents a potential collaboration (33-38). It is necessary to invest time in the selection process of such a supplier due to its influence on the product and a firms' success [9].

3.3. Systematization scheme of measures

Table 1 illustrates the aggregation of the seven distinct characteristics (3.1) of the measures (3.2) in a scheme. One

dimension of the scheme represents the measures for the involvement (vertical). The second dimension is given by the criteria (horizontal). This mapping allows the identification of gaps in research and of focus areas of measures in literature.

Table 1. Systematization scheme of measures

				Phase of product creation process						Phase of procurement process					Levels of responsibility					Potential				Market power						Role of procure-ment		
																								Demand power			Supply power					
			Category of measures	Ideas	Product definition	Concept development	Product development	Start-up	Series/Project	Project ideas	Development	Sourcing-strategy	Supplier relationship	Negotiations	Controlling	Policy responsibility	Structure responsibility	Preparation responsibility	Operation responsibility	Specification responsibility	Reduce costs	Increase performance	Mitigate risk	Increase flexibility	Low	Medium	High	Low	Medium	High	Driver	Influencer	Participant
Incentive system	1	Award	A						x				x			x	x					x			x				x		
	2	Suppliers Day		x	x					x			x				x	x			x	x		x			x			x		
	3	Revenue sharing				x	x						x					x				x	x			x			x	x		
	4	Benefit sharing				x	x						x					x				x	x			x			x	x		
	5	Suppliers workshop		x				x		x			x					x	x	x	x	x	x			x			x			
	6	Regular supplier visits				x	x	x	x				x		x	x	x					x	x	x			x			x		
Sourcing	7	Single Sourcing	B			x	x					x					x			x	x	x				x			x	x		
	8	Dual Sourcing					x	x				x					x			x	x		x	x			x			x		
	9	Multiple Sourcing						x	x			x					x				x		x	x			x		x			
	10	Local/Domestic Sourcing				x	x	x				x					x			x			x	x			x		x			
	11	Global Sourcing					x	x				x					x				x	x	x	x			x		x			
	12	Parts-Sourcing						x	x			x					x				x		x	x	x	x			x			
	13	Component-Sourcing						x				x					x				x		x			x			x			
	14	Modular-Sourcing				x	x	x				x					x			x	x	x				x			x			
	15	System-Sourcing				x	x					x					x			x	x					x			x			
Develop-ment depth of suppliers	16	In-house development	C			x	x						x						x				x		x			x			x		
	17	Interfaced model				x	x						x						x	x		x	x	x			x			x		
	18	Team model				x	x						x						x	x		x	x				x			x		
	19	Black box development				x	x						x						x	x	x	x			x			x			x		
	20	External development				x	x						x						x	x	x	x			x			x			x		
Supplier selection procedure	21	Bid invitation	D				x	x						x				x			x		x	x			x			x		
	22	Online auction						x	x					x				x			x		x	x			x		x			
	23	Concept competition			x	x						x	x					x	x	x		x				x			x			
	24	Request for Information			x	x	x	x	x				x	x				x					x			x			x			
	25	Request for Proposal						x	x					x				x				x	x			x			x			
	26	Direct award			x	x	x	x				x	x	x		x	x					x	x			x			x			
Standardi-zation, bundling	27	Standardization	E			x					x									x	x		x			x			x		x	
	28	Bundling across product lines				x					x									x	x		x			x		x		x		
	29	Bundling across product generations				x					x									x	x		x			x		x		x		
Others	30	Product benchmarking	F			x					x									x	x			x			x			x		
	31	Purchase of a supplier		x	x	x	x					x				x				x		x		x				x			x		
	32	Supplier development			x	x						x				x				x	x	x	x			x			x			
Cooperat-ion within the creation process	33	Idea generation with supplier	G	x						x									x	x		x				x			x	x		
	34	Product definition with supplier			x					x	x								x	x	x	x				x			x	x		
	35	Concept development with supplier				x					x	x	x						x	x	x	x	x			x			x	x		
	36	Process development with supplier					x				x		x						x	x	x	x	x			x			x		x	
	37	Pilot production						x						x					x			x			x			x				x
	38	Renegotiations of certain conditions							x					x		x				x					x		x			x		

3.4. Discussion and conclusion

This section focuses the discussion of the results presented in the systematization scheme. Most of the measures address the concept (PCP-3) and product development (PCP-4) phase while idea generation (PCP-1) is just supported by a small number of measures (see Fig.1). The later phases of the PCP-5/-6 feature more measures then the early phases (PP-1/-2), which implies that there is a potential need for additional measures. Within the PP, measures focus on phases of sourcing-strategy (PP-3) and supplier relationship (PP-4). Again the early phases of the PP-1/-2 are equipped with fewer measures than the later phases (PP-5/-6), which allows the same implication like for the PCP, that additional measures especially for the early phases seem to be a gap in literature. Fig. 1 illustrates a comparison of the number of measures in regard to the phases of the PCP and PP. As these phases are meant for a concurrent execution, the diagonal characterizes an aligned appliance of measures. Hence, most of them are on the diagonal, there are a significant number of measures are under the diagonal. This indicates that these measures are applied in a later stage of the PCP than intended, which might have a significant influence on their operating performance.

Procurement Process (PP)	PCP-1	PCP-2	PCP-3	PCP-4	PCP-5	PCP-6
PP-6			1	1	1	2
PP-5				1	5	4
PP-4			3	7	1	
PP-3	1	4	7	11	8	3
PP-2		1	5			
PP-1	3	2				

Product Creation Process (PCP)

Fig. 1: Comparison of measures for the PCP and the PP

The analysis of the other distinctive characteristics of the measures reveal that the incentive system (A) mainly address the supplier relationship, while measures of souring (B) approach sourcing-strategies. Just two measures (A) aim at policy responsibility, while half of them (A-G) address the specification responsibility. Literature provides numerous measures for the 2nd highest level of responsibility (structure), which mainly refers to sourcing (B). This reveals that only two measures (1 and 6) require a high level of responsibility (policy), which might be due to the presumed trust upon manufacturing firms and suppliers. The measures are equally distributed over the different areas of potential, although reduce cost and mitigate risk represent the major potentials. This underlines the outstanding relevance of those indicators for manufacturing firms. Most of the measures (A-D, G) cope with medium or high demand power and supply power, which illustrates a concentration of the measures in terms of the market power. The majority of the measures (A, B, D-G) refer to procurement as a driver, while only one (G) sees it as a participant. This indicates and emphasizes the strategic role that procurement takes in manufacturing firms.

4. Outlook on future work

A first step of future work is the extension of the scheme in terms of further measures and criteria as well as in a review on their appliance in practice. The scheme focuses on academic literature that characterizes measures under ideal manners, however their appliance and characteristics may vary in practice, which was carried out during the evaluation of the scheme within the expert focus group. As a result, a next step of future work is an empirical investigation of the conducted measures in an industrial case study.

References

[1] Erens F, Verhulst K. Architectures for product families. Computers in Industry. 1997;33:165-78.
[2] Prahalad CK, Hamel G. The Core Competence of the Corporation. Harvard Business Review. 1990:79-91.
[3] Bardi A. Corporate strategies and organisational models, lines of development and evolutionary trends in the automobile sector. 2002. p. 47.
[4] Chen IJ, Paulraj A, Lado AA. Strategic purchasing, supply management, and firm performance. 2004;22:505-23.
[5] Novak S, Eppinger SD. Sourcing By Design: Product Complexity and the Supply Chain. Management Science. 2001;47:189-204.
[6] Petersen KJ, Handfield RB, Ragatz GL. Supplier integration into new product development: Coordinating product, process, and supply chain design. Journal of Operations Management. 2005;23:371-88.
[7] Caniëls MCJ, Gelderman CJ. Power and interdependence in buyer supplier relationships: A purchasing portfolio approach. Industrial Marketing Management. 2007;36:219-29.
[8] Wildemann H. [Advanced Purchasing - Guideline for the integration of supply markets in the product creation process] Advanced Purchasing - Leitfaden zur Einbindung der Beschaffungsmärkte in den Produktentstehungsprozess. München: TCW Transfer-Centrum; 2013. German.
[9] Groher EJ. Gestaltung der Integration von Lieferanten in den Produktentstehungsprozess (Diss.).[Design of the integration of suppliers in the product creation process]: TU München,; 2002. German.
[10] Gausemeier J, Hahn A, Kespohl HD, Seifert L. Vernetzte Produktentwicklung - Der erfolgreiche Weg zum Global Engineering Networking.[Linked product development - The successful way to global engineering networking] München: Hanser; 2006.German.
[11] Pahl G, Beitz W, Feldhusen J, Grote K-H. Engineering Design: A Systematic Approach. Berlin: Springer; 2007.
[12] Ulrich KT, Eppinger SD. Product Design and Development. 5. ed. New York: McGraw-Hill; 2012.
[13] Werner H. Supply Chain Management. 4. ed. Wiesbaden: Gabler; 2010.
[14] Kim J, Shunk DL. Matching indirect procurement process with different B2B e-procurement systems. Computers in Industry. 2004;53:153-64.
[15] Peiro J, Steiger P. Making electronic commerce easier to use with novel user interfaces. Electronic Markets. 1998;8.
[16] Grieger M. Introducing electronic marketplaces for electronic supply chain management,. Proceedings of the Sixth European Logistics Association (ELA) Doctoral Workshop,2001.
[17] Keough M. Buying your way to the top. McKinsey Quarterly. 1993:41-62.
[18] Wynstra F. Purchasing Involvement in Product Development [Diss.]: Eindhoven University of Technology; 1998.
[19] Wannenwetsch H. [Integrative material management and logistics] Integrierte Materialwirtschaft und Logistik. Heidelberg: Springer; 2010. German.
[20] Schuh C, Kromoser R, Strohmer MF, Pérez RR, Triplat A. The Purchasing Chessboard. Berlin: Springer; 2009.
[21] Wildemann H. [Purchasing capability analysis: Program for cooperative exploitation of economization potentials] Einkaufspotenzialanalyse: Programme zur partnerschaftlichen Erschließung von Rationalisierungspotenzialen. München: TCW Transfer-Centrum; 2008. German.
[22] Stollenwerk A. Wertschöpfungsmanagement im Einkauf [Value management in procurement]. Wiesbaden: Gabler; 2012.